

Private Sector Forestry Research A Success Story From India

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ABSTRACT

Almost the entire 76 million ha recorded forest area is owned and managed by the State Governments in India. Forestry research by the State Forest Departments and various Forest Research Institutes under the Indian Council of Forestry Research and Education is funded by the Government. Legislation for sui generis protection for breeder's rights is still pending, and there is no mechanism for certification of seed of forestry species or registration of clones. There is no wonder, therefore, that there is little incentive for private sector investments in forestry research.

Despite many constraints, ITC Bhadrachalam has been implementing a major research and development project since 1989 with a view to improving the productivity and profitability of plantations and making farm forestry an attractive land use option. Major R&D thrust has been on genetic improvement of planting stock and improvement of package or practices. Major gains in productivity of eucalypts have been achieved in a short time span through applications of vegetative propagation and cloning techniques with gainful exploitation of existing useful variation and development/deployment of locality specific, high yielding, fast growing and disease resistant clones.

Starting with cloning of 64 CPTs of eucalyptus tereticornis and Mysore Gum during 1989, more than 500 CPTs have been cloned so far. Based on the performance of individual clones in the field trials, 72 promising, fast growing and disease resistant clones have been identified. These clones are known as Bhadrachalam' clones with productivity ranging between 12-44 cum/ha/yr. Under rainfed conditions compared to 6-10 cum/ha/yr. productivity of normal seed route plantations. Further, research work for identification of still better clones is continuing. Several intra-specific hybrids have been developed through controlled pollination between selected best 'Bhadrachalam' clones of E.tereticornis. Hybrid progeny is under evaluation and many hybrids are showing extremely good promise at one year age. Development of inter specific hybrids between E.tereticornis and E.urophylla/E.torelliana is progressing well.

Extremely well defined research objectives, competent and committed scientific personnel continuity of research plans and personnel, adequate delegation with accountability and wholehearted support at the topmost level of the Company have been key factors leading to emergence of ITC Bhadrachalam as respected pioneers in the field of clonal technology and technology based plantations in India. Company's efforts have been recognised with three prestigious awards and technical consultancy assignment for World Bank aided Forestry Development Project in Maharashtra State.

Key Words: eucalypts, clones, productivity, Casuarina, genotype, environment.

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INTRODUCTION

Almost the entire 76 million has recorded forest area is owned and managed by the State Governments in India. Unfortunately, the forests are under intense biotic pressures leading to degradation of forest resources and 26 million ha of forest area comprise of open forest less than 40% crown cover density and 5.7 million ha scrub. (Anon 1998). This is a great paradox and tragedy of immense proportions for an overpopulated country. And yet, forest-based industries or corporate sector are denied any role in the reforestation of degraded forest lands.

There are statutory ceilings limiting the agricultural land holdings both for individual farmers and corporate sector to extremely low levels in all States, eg. upto 54 acres of worst category of land in Andhra Pradesh. (Reddy & Reddy, 1995). It is therefore not possible for any wood based industrial unit or private sector company to own adequate land for raising intensively managed technology based captive plantations.

Forestry research by the State Forest Departments and various Forest Research institutes under the Indian Council of Forestry Research and Education (ICFRE) is funded by the Government. Legislation for sui generis protection for breeder's rights is still pending, and there is no mechanism for certification of seed of fory species or registration of clones. Research in agroforestry is also carried out by the universities and Indian Council for Agricultural Research (ICAR). There is no wonder, therefore, that there is very little incentive for private sector investments in forestry research.

A very limited number of Non Governmental Organisations, certain research institutes supported with donations like Tata Energy Research Institute (TERI), New Delhi, are engaged in research in limited areas related to forestry. Some integrated pulp and paper mills of late have started promoting farm forestry plantations with limited research and extension support. The only major exceptions of significant forestry research and promotion of technology based plantations by the private sector being applied research in case of Poplars by Wimco Seedlings Ltd., and clonal technology research and technology based plantations of Eucalyptus and Casuarina by ITC Bhadrachalam Paperboards Limited (ITC Bhadrachalam). (Nair et al, 1996)

This paper discusses the success story of

development and commercial scale deployment of high yielding, fast growing and disease resistant clones of eucalypts and Casuarina, and the promotion of technology based clonal plantations through the pioneering efforts of ITC Bhadrachalam.

FARM FORESTRY PLANTATIONS

An integrated pulp and paper mill with 40,000 tonnes/year capacity was established by ITC Bhadrachalam, at Sarapaka, near the temple town of Bhadrachalam in a remote tribal belt of Khammam District of Andhra Pradesh State during 1979. The mill at present has a capacity of 65,700 tonnes pulp and 210,000 tonnes high quality paper boards and paper annually. For pulp production, 40,000 tonnes bamboo from Government owned forests and 124,000 tonnes hardwoods (bone dry weight) primarily from the farm forestry plantations, are procured annually. Company has been very keen to invest in captive industrial plantations for ensuring future supplies of high quality pulpwood in a cost effective and sustainable basis. (Anon, 1997). However, because of statutory ceilings on the agricultural land holdings and current Government policy not to involve industries in reforestation of degraded forest lands owned by the Government, it has not been possible to develop captive industrial plantations.

The company, therefore, opted for the only alternative to promote farm forestry plantations on marginal agricultural lands by providing high quality seedlings, technical extension services and buy back guarantees at remunerative prices to farmers. 6185 farmers in 1138 villages were assisted to promote 7441 ha of eucalyptus plantations with 17.4 million seedlings during 1987-1995. Unfortunately, genetically improve planting stock of short rotation pulpwood species like eucalyptus, leucaena and Casuarina, popular with the farmers, was not available. Therefore, the productivity and profitability of seed route plantations has been very low ranging between 6-10 cum/ha/yr. (Lal 1993, 1995).

CLONAL TECHNOLOGY RESEARCH AND DEVELOPMENT

With a view to improving the productivity and profitability of plantations and making farm forestry an attractive land use option, the company has been implementing a major research and development project since 1989 with main thrust on genetic improvement of planting stock and improvement of package of practices. Major gains in productivity of

eucalypts have been achieved in a short time span through applications of vegetative propagation and cloning techniques with gainful exploitation of existing useful variation and development/deployment of locality specific, high yielding, fast growing and disease resistant clones. (Lal et al 1993, 1994)

Methodology adopted has been selection of candidate plus trees with most desirable qualities, cloning of the Candidate Plus Trees (CPTs) through rooting of juvenile coppice shoots under controlled environment in the green houses. Evaluation of comparative genetic superiority of clones through replicated field trials, genotype X environmental interaction studies to identify a group of superior clones most adaptable to specific sites and soil types and commercial scale multiplication and field planting of selected genetically superior clones.

Starting with cloning of 64 CPTs of Eucalyptus tereticornis and Mysore Gum during 1989, more than 500 CPTs have been cloned so far. Progeny of all clones has been planted in the gene banks as well as replicated field trials for evaluation. 49 clonal testing areas covering 16 ha, 6 clonal demonstration plots covering 14 ha, 2 clonal seed orchards covering 1 ha and extensive gene banks covering 17 ha have been planted.

Based on the performance of individual clones in the field trials, 72 promising, fast growing and disease resistant clones have been identified. These clones are known as 'Bhadrachalam' clones with productivity ranging between 12-44 cum/ha/yr. under rainfed conditions compared to 6-10 cum/ha/yr. productivity of normal seed route plantations. Further, research work for identification of still better clones is continuing.

CURRENT RESEARCH & DEVELOPMENT FOCUS

Vegetative propagation and cloning techniques exploit full productivity potential of superior genotypes. However, no further enhancement of productivity or improvement of genetic qualities of selected clones is possible. In order to develop still better clones than the best available presently and for widening the genetic base of clonal plantations, following research and development priorities identified have been identified and the same are under implementation:

- Selection of additional candidate plus trees for cloning and field evaluation continues as a

regular feature of the strategy for development and deployment of new clones.

- Field testing and selection of highly productive site specific clones for refractory sites including saline and alkaline soils through genotype X environment interaction studies is a high priority research focus. 'Bhadrachalam' clones 1, 71, 130 272, 404, 405 and 406 have already demonstrated good tolerance to calcareous/alkaline soils with fairly high productivity.
- Development of intra specific hybrids through control pollination between best 'Bhadrachalam' clones of *E.tereticornis* and inter-specific hybrids of these clones crossed with *E.urophylla* and *E.torelliana*. F1 hybrids showing good heterosis will be cloned.
- Development of clonal seed orchards for production of improved genetically superior seed for future seed route plantations.
- Further improvement of technical package of practices for field plantations and clonal nurseries.

Several intra-specific hybrids have been developed through controlled pollination between selected best 'Bhadrachalam' clones of *E.tereticornis*. Hybrid progeny is under evaluation and many hybrids are showing extremely good promise at one year age. Development of inter specific hybrids between *E.tereticornis* and *E. urophylla/E. torelliana* is progressing well. (Lal et al 1996, 1997).

Encouraged with the unique success story of 'Bhadrachalam' clones of *Eucalyptus*; similar research work for development and deployment of genetically superior clones of *Casuarina* has been making rapid progress since 1994. 129 CPTs of *Casuarina* have been successfully cloned and gene banks have been established. Field trials are in progress for evaluation of comparative genetic superiority of these clones, with a view to selecting locality specific, disease resistant clones with high productivity. (Lal et al 1996 a).

IMPROVED PACKAGE OF PRACTICES

Thrust areas in respect of improvement of package of practices have been through preparation of site through deep ploughing, effective preventive and control measures against termites during the

critical establishment stage after transplanting, cultural practices including timely weeding and soil working, protection against damage by insect pests and cattle, maintenance of soil fertility through raising leguminous crops in between the 3M wide planting rows for green manuring and application of fertilisers to supplement deficient plant nutrients.

IMPROVEMENT OF NURSERY PRACTICES

The entire clonal planting stock of eucalypts and Casuarina is being raised in modern root trainer nurseries using vermiculite as the growing medium. Improved package of practices for ensuring best possible results in respect of rooting of cutting in the green houses under controlled environment and subsequent maintenance and nursing of plants in the shade houses and open nurseries have been standardised through intensive research. Schedules for fertiliser and micro-nutrients applications have been refined and perfected for large scale commercial production of clonal planting stock. Prophylactic and control measures against common leaf spot disease of eucalypts at nursery stage have been identified e.g. Bavistin has been found to be most effective to control *Cylindrocladium* and Dithane M-45 as well as Blitox are quite effective against *Alternaria* leaf blight.

PLANTATIONS DEPARTMENT PLANS ORGANISATION

The Plantations Department of the Company headed by the Vice President -Plantations, has complete freedom to decide research priorities, technical issues and implement research and clonal production/marketing subject to the approval of financial expenses by the Managing Director. Vice President (Plantations) is assisted by Chief Manager (Plantations Research & Clonal Plant production), supported by eight managers. Like wise, Chief Manager (Plantations) supported by eleven managers assist the Vice President (Plantations) in respect of farm forestry extension, promotion of technology based plantations and marketing of clonal planting stock. Four junior managers provide secretarial and office support services.

Extremely well defined research objectives, competent and committed scientific personnel, continuity of research plans and personnel, adequate delegation with accountability and wholehearted support at the topmost level of the Company have been key factors leading to emergence of ITC Bhadrachalam as pioneers in the field of clonal

technology and technology based plantations in India. Company's efforts have been recognised with three prestigious awards and technical consultancy assignment for World Bank aided Forestry Development Project in Maharashtra State. (Lal et al 1997).

APPLICATION AND TRANSFER OF RESEARCH FINDINGS

Planting stock of selected 'Bhadrachalam' clones has been supplied to Forest Development Corporations/ Forest Departments of various States and Forest Research Institutes to enable them plant clonal seed orchards and maintain their own gene banks for future multiplication of these clones. Andhra Pradesh Forest Development Corporation (APFDC) is implementing a World Bank funded Industrial Plantations Project to plant 17500 ha degraded forest lands with 'Bhadrachalam' clones of eucalypts.

Clonal planting stock of 'Bhadrachalam' clones of eucalypts has been supplied to Forest Departments/ Forest Development corporations of Tamil Nadu, Kerala, Karnataka, Andhra Pradesh, Maharashtra, Gujarat, Madhya Pradesh, Orissa, West Bengal and Haryana. Like wise, 'Bhadrachalam' clones have been supplied to Institute of Forest Genetics and Tree Breeding, Coimbatore, Kerala Forest Research Institute, Peechi and many wood based industrial units.

Clonal saplings of 11 best clones with productivity of 20-44 cum/ha/yr under rainfed conditions are being supplied to farmers for raising clonal farm forestry plantations with technical extension services and buy back guarantees provided by the Company. Two Clonal Demonstration Plantations (CDPs) were established during August 1991 based on five shortlisted clones with outstanding performance in CTA I at two years age. Additional CDPs have been established in three districts of Andhra Pradesh covering 15 ha area.

Clonal planting stock of the most promising 'Bhadrachalam' clones was released to farmers on selective basis from 1992 onwards. As seeing is believing for the farmers, these demonstration plantation and successful extension campaigns by the field staff of ITC Bhadrachalam have been instrumental in large scale acceptance and vast popularity of 'Bhadrachalam' clones. (Lal et al 1997)

Between 1992-95, 0.78 million clonal saplings were supplied. Supply of clonal plants exceeded one

million saplings during 1996. 1.3 million clonal saplings were supplied during 1997 and supplies during the current year 1998-99 will be around 2 million saplings. A uniform selling price has been charged from all clients including the farmers, Forest Departments and forest Development Corporations for supply of clonal planting stock. Selling price was Rs. 7/- or roughly 19 cents per sapling ex Clonal Plant Production Centre at Bhadrachalam for the years 1996 to 1998. Total area planted with 'Bhadrachalam' clones of Eucalyptus upto 1998 will be more than 3000 ha involving nearly 2000 farmers.

Findings of the clonal technology research and experiences gained in the promotion of technology based plantations have been published in the Indian Forester, and proceedings of various national level and international seminars/conferences. (Lal 1991, 1992, 1993, 1994, 1995 1996; Lal et al 1992, 1993, 1993a, 1994, 1996 1997). Printed copies of the improved package of practices for clonal plantations have also growing demand for planting stock of 'Bhadrachalam' clones is a testimony of their popularity and genetic superiority.

FUNDING OF RESEARCH & EXTENSION COSTS

The entire clonal technology research and farm forestry extension programmes are funded internally by the Company. The sale proceeds of clonal planting stock at the current level meet only part of the production, research and development, staff and administration, depreciation and the interest costs. Yet, the company continues to support this activity which is vital for securing future pulpwood supplies.

During the period 1986-87 to 1997-98, ITC Bhadrachalam spent Rs. 3.19 crores, on promotion of farm forestry plantations and providing technical extension services. Likewise, during the period 1989-90 to 1997-98 the company spend Rs. 2.88 crores towards operating expenses and administration costs in respect of clonal technology research/development and production of clonal planting stock. Capital expenditure incurred during the period 1989-90 to 1997-98, mainly for establishment of green houses, shade houses, modern root trainer nurseries, lab equipment for vehicles, etc., has been Rs. 1.50 crores. A sum of Rs. 2.36 crores has been recovered towards sale proceeds of seedlings and clonal planting stock upto 1997-98.

However, the company now wants the Plantation

Department to be self reliant and self supporting for funding future expenses. As the demand for clonal planting stock is growing very fast and production capacity has been expanded to 2.3 million clonal saplings per year during 1997-98. Research & Development expenses and fixed overhead costs will be spread over larger volumes. Plantations Department hopes to be self sufficient in funds through sale proceeds of clonal planting stock within 1-2 years and simultaneously achieving the primary objective of securing future pulpwood supplies through clonal farm forestry plantations.

CO-ORDINATION OF RESEARCH AND LINKAGES

After the visit of top executives of ITC Bhadrachalam to Aracruz in Brazil during 1987, the company solicited transfer of technology and consultancy services from Aracruz Florestal, S.A. and some renowned international consultants. However, the arrangements could not be finalised because of the exorbitant price tag, which ITC Bhadrachalam just could not afford. Therefore it was resolved to be self reliant and make earnest efforts to succeed through in-house efforts. A separate Plantations department was created during 1989.

Collaborative arrangements initially for two years were finalised with Tata Energy Research Institute (TERI), which were extended for another four years term. It was a learning process for both the organisations. Even now, need based assistance in the areas like plant pathology, entomology and soil science, etc. is sought from scientists of Agricultural Universities and Forest Research Institute/organisations is most welcome.

Generous help was provided by APFDC and the farmers of Andhra Pradesh who permitted the company scientists to select CPTs for cloning from their seed route eucalypts plantations. As ITC Bhadrachalam did not have any breeding populations or extensive seed route eucalypts plantations, CPTs selected from APFDC and farm's plantations contributed to the vital foundations of company's clonal technology research and development programme. Later some clones were also received on exchange basis from Institute of Forest Genetics & Tree Breeding and from Wimco Seedlings Limited, Rudrapur, Uttar Pradesh for trials in Andhra Pradesh. Unfortunately, none of the clones received from these two sources performed well to qualify to be shortlisted as promising clones suitable for large scale

commercial multiplication.

There are great merits in collaborative research because of tremendous savings in costs through minimizing duplication of equipment, manpower and expenses on repetitive research. Likewise, there is great benefit from saving of valuable time and developmental costs by arranging transfer of technology already developed, which may suit the requirements of other interested clients ITC Bhadrachalam has also recently finalised arrangements with Mysore Paper Mills Limited for collaboration regarding domestication of CPTs from extensive *E.camaldulensis* plantations of the later for cloning and field evaluation. It will be extremely useful if all State Forest Departments having large scale eucalypts and *Casuarina* plantations could join hands to select CPTs for cloning and planting of multi locational trials in the all the States for simultaneous field evaluation of clones. Simultaneously, shortlisted 'Bhadrachalam' clones and all new clones to be developed as above, can be planted on problematic sites like saline/ alkaline and other refractory sites to study genotype X environmental interaction for selecting promising future clones most adapted to each specific site in various states promoting Eucalyptus plantations.

ITC Bhadrachalam has also announced a policy decision about their willingness to supply genetically improved clonal planting stock of 'Bhadrachalam' clones to any wood based industrial unit in the country, all State Forest Departments and research institutes. The company is also willing to provide technical consultancy services for transfer of clonal technology to any organisation in the public or private sector on mutually agreed basis.

ITC Bhadrachalam is keen to develop linkages for mutual co-operation with other research institutes and the company is a member of APAFRI and IUFRO. A proposal has been submitted to Indian Paper Makers Association (IPMA) for setting up of a National level Clonal Technology Research Institute for genetic improvement of pulpwood species. The Federation of Indian Plywood & Panel Industry and associations of other wood based industries may join IPMA for establishing, funding and managing the proposed National level Research Institute. Such a research institute shall focus research and development thrust on major issues of highest priority to the member industries. Pooling of financial and human resources as well as equipment through the proposed institute will make the research cost effective, and

results will be available for commercial use by all member industries. Association Foret Cellulose (AFOCEL) in France is a very successful example worth emulation by forest based industries in India. Forestry research in government sector institutions suffers from lack of focus, thrust, absence of prioritisation, too frequent changes in the personnel and research priorities, lack of accountability and procedural/bureaucratic delays. Private sector has been able to address most of these negative bottle necks and achieve extremely successful results in a short time span with minimum costs. However, lack of availability of sophisticated equipment, inadequate genetic resources, absence of breeding populations, non-availability of land for field trials, limited staff and shoe-string budgets for research and development and publicity for promoting sale of clonal planting stock are some of the major constraints under which ITC Bhadrachalam had to operate. But for these constraints, the achievements would have been far more commendable and faster.

CONTRIBUTION OF CLONAL TECHNOLOGY RESEARCH

Extremely fast growing, high yielding and disease resistant clones of eucalypts have been developed for the first time in India by ITC-Bhadrachalam. Productivity of 'Bhadrachalam' clones of eucalypts is 2-3 times higher compared to normal seed route plantations. Clonal eucalypts plantation in India is the successful example of commercial scale clonal plantations of any forestry species traditionally propagated through seed.

Clonal Plantations covering 1.25 Million ha or 33% of the degraded forest areas in Andhra Pradesh alone can yield 25 million tonnes of pulpwood annually, sufficient for meeting our country's entire pulp and paper requirements projected at 8.5 million tonnes by 2010-11, based on 70% wood fibre furnish. Likewise, high yielding short rotation clonal plantations can meet country's firewood requirements thereby minimising biotic pressures on remaining natural forests and conserve their rich bio-diversity.

ITC-Bhadrachalam will be able to release genetically improved clones of *Casuarina* for commercial scale farm forestry and reforestation projects in the near future. Immense gains in productivity and improvement of quality of produce in a short time span and possible through applications of similar cloning techniques for many important indigenous species amenable to vegetative propagation

e.g. Tectona grandis, Gmelina arborea, Pinus roxburghii, Dalbergia sissoo, Anthocephalus chinensis and Dipterocarps, etc. (Lal 1995, M. Pal, 1993). Unfortunately, forestry research organisations of the State Forest Departments and ICFRE institutions have not accorded richly deserved high research priority for development and large scale deployment of genetically improved clones of important indigenous species. No wonder, the country pays very high price for continuing large scale use of un-improved seed for most tree species in the farm forestry and reforestation programmes.

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